INTERNATIONAL FARM MANAGEMENT CONGRESS 2003
FARMING AT THE EDGE

# THE IMPACT OF BIOTECHNOLOGY, IN PARTICULAR GENETICALLY MODIFIED CROPS ON INTERNATIONAL AGRICULTURAL RESEARCH, PRODUCTION AND MARKETING AND HOW THIS WILL AFFECT AGRICULTURE IN WESTERN AUSTRALIA.

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## Abstract

In 2000 I was awarded a Nuffield Farming Scholarship to study the impact of biotechnology, in particular genetically modified [illegible] Western Australia. I was impressed by the technology available that opened up a range of opportunities for vast improvements in production traits, quality of food, food safety and environmental and human health benefits. I also gained an understanding of the challenges faced by Canada and the US in production, identity preservation, testing and marketing of GM crops. In contrast the UK gave me a valuable appreciation of the influence of the marketplace in determining the future of GM research and production.

Since my return I have had an opportunity to reflect on what I learnt and assess the impact this has on our decision to grow GM crops in WA in an environment of growing public concern and debate. The technology provides us with a valuable tool for more efficient production and market segmentation and we must take advantage of it to remain competitive in the world market. However, we need to learn from the mistakes made by other countries producing GM crops and commit resources to very good testing and identity preservation systems backed by strong regulatory, research, development and production processes to minimise the risk of making the same mistakes.

## Introduction

Biotechnology is already having a major impact on agricultural production in the countries that have chosen to commercially produce GM crops. In 2002 there were 58.7 million hectares of GM crops grown, 62 percent soybeans, 21 percent corn, 12 percent cotton and 5 percent canola. Four countries account for 99% of global GM area. The USA is the biggest producer with 39 million hectares, Argentina 13.5 million, Canada 3.5 million and China 2.1 million. In Australia, GM cotton is currently the only GM crop grown commercially. These countries represent our major competitors for global markets that are important to WA with its export focus. With the impending release of GM canola in Australia, I was keen to study the issues surrounding GM crops from development of the technology through to grower experiences with GM's and marketing issues. I could then be well informed to determine how these issues would impact on our decision to grow commercial GM crops in Western Australia.

## Research

I think the importance of biotechnology research on the future of agriculture is captured in a statement made by Colin Merritt, Monsanto, Cambridge, UK "Monsanto is no longer pursuing any further development work on new chemicals – all

developmental research will now be in the area of biotechnology". This statement was confirmed recently when Monsanto out sourced chemical business to Nufarm. Investment by large multinational "Life Science" companies such as Monsanto is an indicator of the future of biotechnology in agriculture.

The majority of crop transgenics have been in the area of input traits such as Roundup Ready® Canola and Soybean and BT® Corn with production benefits for growers. Biotech companies such as Monsanto and Aventis are now marketing products which benefit consumers through enhanced output traits in an attempt to both capitalise on investment in research and win back consumer confidence in GM's. The market for pharmaceutical, nutraceutical and industrial enhanced output trait products is also a very lucrative one.

**Canada**

Canada has been growing GM canola commercially since 1995 and 60% canola production is either transgenic or mutogenic. This commercial production has substantial backing from private and public research and development. Collaborative research between government and the private sector and government incentives for biotech research are commonplace. The Canadian Federal government operates a matching investment initiative fund and federal and provincial (state) tax credit schemes, enabling companies to do research for 30% of the cost. The Canadian government released an Innovation White Paper in September 2001 that outlines the plan to make Canada a leader in biotech by 2010 and providing between $12 - $20 billion Canadian to achieve this. The emphasis is on the "bioeconomy" or exploitation of living materials.

Provincial governments have also set up other alliances with the private sector to further expand biotechnology industries. Funding has set up Agwest Biotech Inc that offers start up assistance for companies to market biotech products overseas as well as a public education role. Public support is with the science and food regulation industry in Canada and with successful commercialisation of GM products research is strongly supported. The move towards output traits has led to development of a range of products including:

- Biofuels – using high erucic acid type oilseeds.
- Nexera® canola – (mutogenic not GM) with longer shelf life and higher "smoke" point for higher temperature frying which means faster cooking times and less fat absorbed by food.
- Anti coagulants - using anti coagulant properties from leeches in canola for cost effective pharmaceutical production.

**USA**

The USA is a world leader in biotech research with 300 core biotech companies in 2001 spending $A12 Billion on R&D. As the US is the largest producer of GM crops in the world, the scientific community has the backing of a strong commercial production base, public support and substantial private and government funding. As a result, research into agricultural products with enhanced input and output traits is moving at a rapid pace. Some examples include:

- Roundup Ready® Wheat– There is a big question mark against its release due to market implications for US and Canada as major world wheat producers.

- Terminator gene – This can solve the problem of volunteer Roundup Ready® wheat, outcrossing to conventional varieties and pre harvest sprouting. It has been developed in the labs and it is unlikely to be commercialised due to public concerns over control by multinationals of seed stocks.
- Modified Corn Starch – Dow/Cargill joint venture "Natureworks" bio plastic production from modified corn.
- Spider Silk – developed from goat's milk using strands of protein to create a very strong silk like fabric used in aeronautics.
- Phyto Remediation – using transgenic plants to clean up oil spills by detoxification or uptake by plants.
- Nutraceuticals – Enhanced nutritional content of foods eg Golden Rice®

**United Kingdom**

In contrast to Canada and the USA, research in the UK is progressing much more slowly. There is considerable public opposition to any form of genetically modified foods and this is fuelled by powerful environmental groups such as Greenpeace, Friends of the Earth and the more moderate Soils Association and Royal Society for the Protection of Birds. The more extreme groups have used the GM debate to generate public support. Food safety incidents such as BSE in beef, dioxins in chicken, continuous outbreaks of food poisoning and more recently Foot and Mouth disease have left the public with little faith in government regulators and the scientific and farming community in general. There have also been several sensationalised incidents with GM research that have further fuelled the debate. Large biotech companies such as Monsanto had failed to address the different level of public concern in the UK about the technology, citing results from Canada and the USA and suggesting that it would not be an issue for the UK consumer. Powerful supermarkets have taken advantage of the anti GM public sentiment to turn the issue into one of marketing. Supermarkets own branded products are now non-GM where prior to 1999 GM foods, such as the "flavour saver" tomato paste were clearly labelled and sold.

The environmental debate is the key driver of the anti GM lobby and a major concern is a loss of biodiversity from increasing monoculture, reducing food and habitats for wildlife. The environment and agriculture in the UK have evolved together over hundreds of years and any change in crop management will impact on wildlife. There is fear that modified genes will harm non-target insects and also result in chemical resistant insects. "Super weeds" may be created by outcrossing of genes into the general weed population and modified crops could become weeds themselves. These issues are subject to much tabloid press and counteracting publicity campaigns by biotech research organisations.

The complex environment issue is the focus of much of the GM research in the UK. One major example is the trial funded by the Royal Society for the Protection of Birds and English Nature and run through DEFRA with involvement from Monsanto and Aventis. This trial investigates the management of GM crops and the impact on the environment at 60 sites across the UK. GM crops of sugar and fodder beet, fodder maize and spring and winter oilseed rape are compared directly with their conventional counterparts. Final results will be released after the trial is completed at the end of 2002.

Despite the direct financial involvement of the two largest nature organisations in the UK, trial sites are still subject to sabotage by anti GM extremists. Extremist groups prevalent in the UK and certainly in Europe as a whole have a big impact on rational debate and any meaningful research into GM crops and the British tabloids feed off this activity in publicity campaigns.

**Production**

Commercial production, like research, is very much determined by public sentiment towards GM's and the position in world markets. USA, Argentina and Canada are the leading producers of GM crops in the world whereas there is no commercial production of GM crops in the UK at present.

Canada

About 55% of the 12 million acres planted to canola in 2000 were either Liberty Link® or Roundup Ready® canola grown by 80% of growers. Smart® or IT canola (mutogenic not GM – Canadian equivalent of our Clearfield® canola) constitutes at least 20% while conventional canola now makes up less than 25% of the total canola plantings in Canada. A report into the impact of transgenic canola on the industry was commissioned by the grower organisation Canola Council of Canada. One of the key findings was a reported increase of $C5.80/acre net return compared to conventional canola in 2000. This equates to an equivalent increase in price for conventional canola to be around 10% to justify production.

There is excellent farmer acceptance of GM crops due to reduced management cost. With less than a three month growing season for summer crops in Canada any tool such as Roundup Ready® Canola which enables crops to be established at the first sowing opportunity without the need for a knockdown of weeds prior to sowing has advantages in terms of management and profitability. Canadian farmers have had subsidies reduced considerably over the last few years and support is now in the form of a government subsidised crop insurance scheme. This has increased the need for more efficiency and profitability at the farm level and GM canola is helping achieve this.

There are also some downsides to the widscale production of GM crops. Canadian farmers were very concerned about control by large multinational companies over production. There was strong opposition towards payment of the "Technology Use Agreement" to Monsanto as part of the Roundup Ready® canola package. This is a $C15/acre cost imposed separate to seed and chemical sales aimed at recovering the cost of developing the technology. This equates to about $A40/ha which I would question as a disincentive for Australian farmers to grow GM canola without looking at the overall benefits. An end use royalty system of capitalising on the technology may be a more attractive system for us.

Farmers were also keen to maintain competition between companies in the marketplace and were concerned by large multinationals such as Monsanto investing in many smaller seed and biotech companies and reducing competition. There are also rising concerns, fuelled by media hype, about "superweeds" and outcrossing of resistant genes to conventional types and wild species.

Herbicide resistance is also a growing concern amongst producers and resistance by weeds to glyphosate in Canada is inevitable given its widespread use in other crop rotations as it is here in Australia. Given the existing problem we have with annual ryegrass resistance to glyphosate we need to weigh the benefits of adoption of glyphosate tolerant canola against the increased selection intensity for resistant ryegrass. A "systems" approach to including Glyphosate tolerant canola in crop rotations would be an important first step to adoption in conjunction with workable stewardship programs.

Despite these issues, the overall impression I had from talking to farmers was that the benefits of GM canola outweighed the real and potential costs and this has been reflected in an increase in area of GM canola in 2001.

**USA**

There is widespread community financial and moral support for the US farmer who is seen as a family farmer struggling against low prices and the vagaries of the weather. In reality, commercial grain producers receive up to 30% of their incomes from the government and are not hamstrung by a regulation. The benefits of GM technology have added to this ideal production environment. In 2002, 71% of cotton and 34% of Corn production were either BT or Roundup Ready®, and 75% of Soybean was Roundup Ready®. Uptake of GM Soybean has been particularly high as weed control was previously difficult due to its sensitivity to a range of chemicals.

There has been much positive publicity about the benefits of GM crops, and facts such as a reduction of a million gallons in applied insecticides to GM cotton carry weight with the public. The use of hazardous, residual chemicals in soybeans has been replaced with the safer glyphosate chemical. Issues that have arisen such as the impact of BT Corn on the Monarch butterfly have been quelled by scientific evidence that the effects are minimal. The more recent Starlink® corn case did cause more public concern as the public faith in regulatory bodies was tested.

**United Kingdom**

Currently there is no commercial production of GM crops in the UK. The general feeling among the farming community is one of acceptance of the technology as the potential for improving production efficiency is obvious. The intensive, high yielding nature of crop production in the UK would benefit immensely from GM technology, especially in the area of disease resistance. Output trait products would also be well suited to these intensive systems. However, there is concern about the marketability for products given current public opinion, although focus on marketing of products is distorted by the desire to make maximum gains from the subsidy system. There is also concern about farm and personal security with the threat of sabotage of crops by extremist groups.

Public opinion towards the farming community has softened a little and awareness of some of the issues affecting UK farmers has increased after the foot and mouth disease (FMD) outbreak. Devastating footage of piles of dead animals being burnt brought some sympathy. The GM debate has also been highlighted by FMD in terms of food safety and biotech companies are working hard in the public arena to dispel fears of the science. There now appears to be a slight softening of attitudes towards the issue. The European stance on GM's is an important one for us to follow as it impacts on markets and consumer views not only in Europe but also to an extent in South East Asia.

**Marketing**

**Canada**

As Canada competes with Australia for major canola markets into Japan, China and Mexico and 60% of their production is GM there were some interesting lessons to be learnt from their experiences. Similarities such as Canada being a net exporter of grains and with little government support also highlight the usefulness of the Canadian experience. The limited concern amongst Canadian producers to the overseas market implications of growing GM crops was interesting. To put this in perspective though, the major market for Canadian canola is Japan which does not require specific GM labelling for highly processed foods such as canola oil and tolerance thresholds for labelled products are 5% compared to 1% in most other markets. Japanese public opinion is not strongly anti GM so lack of concern by Canadian producers is not suprising. There have been glitches in this system that highlighted the need for strict adherence to registration requirements of GM products sold to other countries.

Canada has a small market of 110 000 tonne of non GM canola into Europe at a tolerance level of 1% GM content. The "Identity Preservation" (IP) of this from GM canola has tested the grain handling system through Western Canada to Vancouver and Eastern Canada through the Great Lakes system. There have been some issues of co-mingling through this system and it does appear that the Canadian grain industry is playing catch up with its IP and testing systems in an attempt to keep up with GM production increases and overseas market requirements. These systems will need to be fine-tuned when output trait products come into the marketplace. This experience is one of the most important ones Australia can draw on in choosing to grow GM crops. To have these systems in place before the introduction of GM's is essential.

Regulation of GM's or plants with "novel traits" within the domestic market works on the assumption of "substantial equivalency". This is a regulatory term used to define a product and is a starting point from which the differences, not similarities between GM and normal foods are compared. To take a product from a starting point to the market takes between 3 and 7 years and each variety of seed needs to go through a merit system with a marketing board and seven Federal Agencies for comment on food safety. With the current products on the market companies will need 750 000 acres planted each year for three years to recoup costs.

Within Canada there are well structured and funded opposition groups such as the Sierra Club and the Council for Canadians who work hard at promoting anti GM sentiment amongst the public, but generally the Canadian consumer is accepting of the technology.

**USA**

The US domestic market consumes almost 80% of grain produced and a large proportion of the of the corn and soybean crop is GM. The grain handling system is not able to easily handle IP systems and there could be no guarantee of GM free grain with a tolerance of less than 5% GM content.

The USA is similar to Canada in respect that the GM crops currently grown are "substantially equivalent" to conventional varieties. According to the US Food and Drug Authority (FDA) there is no need to label or segregate these differently and so they are co-mingled with conventional varieties. The public has faith in their regulatory authorities and there has not been the food scares as there has in the UK and Europe. Opposition groups such as Greenpeace do not have the same credibility with the public and there is a general trust of government process. Biotech companies have chosen to have GM food reviewed due to the risk of law suits so have gone through a voluntary process to achieve this.

Other regulatory bodies such as the Environment Protection Agency (EPA) and the US Department of Agriculture are also involved. There is a more complex process involved with registering a new GM crop than a new pesticide. The risk of commercialising a new crop is now reduced with the benefit of experience in the testing process.

The US producer does not seem overly concerned about marketability of GM products. With government support through the US Farm Bill and the large non discerning domestic market the risk of not being able to sell a product is reduced. There are some concerns beginning to emerge with questions around the release of Roundup Ready® Wheat and its acceptance in world markets and this is bringing a new realisation of overseas consumer views into the debate.

**United Kingdom**

With the wide choice and consistent supply of food available in the UK it is difficult for the consumer to see the benefit of GM foods that offer benefits only to the producer. Biotech companies such as Monsanto aim at recouping their investment in technology with input trait crops before releasing the more consumer focused output trait products. The Western society demand for choice of what they eat will eventually provide a market for these output trait products. However, this will only occur if the benefits can be rigorously demonstrated to consumers and food safety and health fears can be addressed.

Companies such as Monsanto recognise this as a serious threat to adoption of the technology and have now taken a much more consultative approach with the public. In the last two years efforts have been directed towards public relations – informing the public and aiming for more rational debate. Collaborative research work with environmental groups on the impact on the environment is part of this process.

As the United Kingdom is a major player in the EU, the strong anti GM stance of the EU is also restricting commercialisation of products. Through the WTO, the Sanitary and Phytosanitary agreement enables countries to check the unjustified use of health regulations that may restrict trade. The EU are endeavouring to introduce a "Precautionary Principle" into this agreement which would restrict trade where science is not able to give a complete answer on the safety of products. This could be used to demonstrate that there are reasonable grounds for harm to humans, animals or the environment. Other countries are concerned that this could be a form of trade barrier. However, if foods have been passed by the FDA in the US there may be little grounds for this principle to be enforced, thus forcing the EU to accept these products. It is interesting to note that since the BSE outbreak in Europe, there has been an increase in the amount of vegetable protein fed to animals, mostly GM soybean meal from the US.

To remain GM free the European consumer will have to pay a cost for identity preservation and at present it is difficult to determine if the general population will pay more for what appears to be the same product.

**The Situation in Australia**

The Australian consumer views on GM foods are positioned somewhere between those of the USA and UK. There is general caution towards GM foods and the debate has increased in the last twelve months with the commercialisation of GM crops

getting closer. Currently there are no GM food crops grown in Australia but GM cotton and carnations are commercially produced.

The Federal government introduced some of the strictest labelling legislation in the world with a tolerance of 0.1% GM content. This is the limit of the level that current testing procedures can test to. This will make it virtually impossible to source GM free processed foods in the supermarket. It is difficult to achieve a sample of crop that is 99.9% pure and most processed foods contain some form of soybean. GM free foods will have to come from the organic sector.

The WA State government is currently debating legislation on the commercialisation of GM crops. Across Australia, there is a three tiered system of regulation set up after GM legislation was passed through government in December 2000. In WA a number of Local Government Authorities have banned GM trials in their Shires. Tasmania has a complete ban on growing any GM crop including trials.

The Grain Pool of WA are currently undertaking an identity preservation trial with a new variety of non GM canola to test handling and testing systems. They are endeavouring to support the commercialisation of GM canola in co-existence with non-GM production.

The agricultural community is now at the crossroads of making the choice on GM crops. Debate has increased and much misinformation has gone out to the public from overseas anti GM campaigners through local sympathisers. The industry as a whole needs rational debate and solid information from the scientific community and marketing organisations in order to make a well informed decision. We need the technology to remain competitive but also need an understanding of what our customers require.

Australia is a valuable market for GM technology and there are products ready to be commercialised that will be attractive to farmers. However, the area based "Technology Use Agreement" will not suit the current crop production system so an end point royalty would better suit the diverse range of production zones in Australia. Industry also needs to develop a self-regulated Stewardship program to minimise the risk of resistance and crop volunteers becoming weeds. These programs can be built into existing quality assurance schemes.

**Conclusion**

The study of biotechnology gave me a valuable insight into the GM issue around the world. This will be valuable to me as we make our decisions here on the adoption of GM crops in the future. After studying the situation in Canada, USA and United Kingdom I think agriculture in Australia will only benefit from adopting GM technology.

Although there is still varying degrees of uncertainty about GM crops in our major markets, I think the benefits of GM's will prevail in the future and the technology will become a part of life.

GM crops are based on good science and will enable us to target markets with specific products suited to our environment and achieve better profitability. We also need to be proactive as an industry to maximise farmer benefits and reduce the risks with the technology through an end point royalty system and Stewardship program.

In WA we are in an enviable situation where we are currently not growing commercial GM crops and are in the process of making that choice. There is no doubt that we need to adopt GM technology in order to remain competitive in the world market. The issue is capitalise on the opportunity to get it right the first time and avoid the problems Canada and the US have with GM production. There is no doubt that the technology will provide us with another valuable tool for more efficient production and market segmentation but at the same time we need to ensure we can identity preserve GM's from each other and from non GM's. We need to commit resources into developing very good testing and identity preservation systems backed by strong regulatory, research, development and production processes to get it right. All of this needs to be done in an environment of market awareness and the moving target of consumer preferences.

**Bibliography**

Sandy Forbes was awarded a Nuffield Farming Scholarship sponsored by the Grains Research and Development Corporation in 2000. A former farmer in Jerramungup, Sandy now works as a Development Officer for the Department of Agriculture Western Australia. Based in Jerramungup, her work covers all aspects of crop, pasture and sheep production, strategic planning and involvement with the local community agricultural research and development groups.